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(Selected Articles)

by

Wang Jia-Ying

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IR Camouflage Technology: State And Development

Wang Jia-Ying

(The 2nd Artillery Academy Qing Zhou Branch Institute Qing Zhou 262500)

Abstract: In this paper, the state of art of IR camouflage technology including infrared suppression, obscuration agent and infrared deception technology are analyzed. The prospect of IR camouflage is discussed.

Keyword IR camouflage IR suppression IR deception

1. Foreword

Infrared technology is extensively used in the area of reconnaissance, capturing target and terminal guidance techniques. The infrared camouflage technology has progressively developed with the development of infrared reconnaissance technology and terminal guidance technology, its development process can be divided into three stages: early development stage, basic theory research stage and application research stage. The 60's was the early development stage of infrared camouflage technology, some research institutes began to consider and study infrared camouflage technology, but it was very difficult, and there was no concrete research achievement. In this period the infrared forward looking system began to equip the army, the point source type infrared guidance technology was mature. The 70's was the basic theory research stage and the experiment stage of infrared camouflage technology. In this period, a large number of the infrared line scan devices, forward looking infrared systems, and point source type infrared guidance missiles equipped the army, it created emergency development conditions for research into infrared camouflage technology. Many countries began the basic research and field experiments one after another. The fixed facility infrared camouflage research also began, some experiment data and achievements were established, but it did not reach the practical

application level. From the 80's, infrared camouflage technology has become the main research topic in the camouflage arena, infrared camouflage shielding and infrared smoke equipment make breakthroughs and reached the practical application level. Infrared camouflage of a fixed facility also made important progress. At that time, the US developed infrared stealth plane, the US, British, Sweden and other countries developed infrared smoke, British and the US joint developed the stealth airfield, in addition, they successfully applied the infrared stealth technology in the missile launching.

2. Infrared Suppression technology

The infrared suppression technology includes three parts, they are reducing the target's infrared radiation intensity, simulating the infrared characteristic of background and infrared deformation.

2.1 The main technical means and measures of infrared suppression technology

2.1.1 Reducing target's infrared radiation intensity

Reducing the infrared radiation intensity of a target itself can reduce the difference of the infrared radiation intensity of the target and background as much as possible. If the sensor can not receive enough energy, of course the probability of being detected, identified and tracked will decrease. The realistic method is shown below:

(1) Air convection heat dissipation. Air is a kind of selective radiator, its radiation concentrates on the wave bands that are out of the atmospheric spectrum, the sensor just works on these atmospheric spectra, so the sensor can only detect the heat target, but can not detect the heated air. In order to utilize this characteristic of the air, foreign armies developed and employed a large amount of systems which utilize air convection. Natural convection does not need applied heating devices, so

it is in special favorable condition; the forced convection needs some devices such as air blower, so it can use cooling fins or heat exchange device to transfer heat, thus has relatively high efficiency.

(2) Infrared camouflage paint and coating material. The infrared camouflage paint or coating material works as heat insulation, reducing the heating effect of sun, controlling the emissivity of target's surface. When using coating material, it is necessary to use the air convection technique to dissipate heat. The mechanism of heat insulation coating material is storing the thermal energy in the coating of a certain thickness to reduce the thermal energy's dissipation and diffusion rate and avoid the sudden changing in temperature. To reduce the emissivity of target's surface, the first method is to employ low emissivity infrared coating material, the second method is to make the emissivity of coating material change with the changing of temperature, employ the working fashions of high temperature low emissivity and low temperature high emissivity, the third method is to move the high emissivity to the wave band out of the infrared spectrum.

(3) Heat insulation layer. The heat insulation layer covers the target's surface to reduce the infrared radiation intensity in a certain direction. It is usually composed of heat insulation materials such as foamed plastic, powder, metal plating plastic film. Currently, Sweden, the US and Germany have developed a heat insulation layer that can be used in coordination with the infrared camouflage net. When using the heat insulation layer, it is common to add a cooling system or air convection system between the target and insulation layer, it is used for cooling and heat dissipation. The heat insulation layers that were developed in recent years all have the hot air control venting hole, the goal is to make the heat insulation layer itself have the ability to control air convection and heat dissipation.

(4) Cooling system of the hot exhausted gas. The temperature of the engine's exhaust pipe and waste gas are all very high, the temperature of

the exhaust pipe can reach 200 ~ 300 °C, the exhausted waste gas is high temperature gas and can produce continuous optical spectrum. To reduce the temperature of the waste gas and exhaust pipe, a dedicated hot exhaust gas cooling system is used. Currently the hot exhaust gas cooling systems being employed in foreign countries are mainly contaminating air cooling systems and liquified fog cooling systems.

(5) Inherent infrared confrontation measures of the target. The inherent infrared confrontation measures of the target mainly refer to employing heat pipe and liquid circuits to move the thermal energy; reducing the heat radiation area; using fuel additives; changing the position of the target's exhaust pipe; employing porous layer material.

2.1.2 Technology of simulating the characteristic of the background /3

Despite the fact that on the battle field, the temperature of the normal temperature target is close to that of the background, its image in the infrared wave band is different from that of the background, so it still could be detected and identified. The technical means and measures of reducing the target's thermal radiation intensity can only make a normal temperature target whose temperature is close to that of the background, they can not completely solve the problem of the target's infrared camouflage. Simulating the infrared characteristic of the background means changing the infrared radiation distribution status of the target, it makes the infrared radiation distribution status of the target and background coordinated, finally makes the infrared image of the target becomes part of the background's infrared image, thus effectively decreases the probability for being detected by the enemy's infrared sensor systems. This kind of technology is suitable for the normal temperature targets. For the high temperature targets, at first it is necessary to lower its temperature and then implement the technology of simulating the background's infrared characteristic. The main technical means which is employed currently is the infrared camouflage net, this

kind of net can effectively reduce the radiation contrast of the target and background, also can change the infrared radiation distribution of the target.

2.1.3 Infrared deformation technology

Different targets have certain infrared image characteristics in different statuses. The infrared imaging reconnaissance and guidance system just use these certain characteristics to identify targets. Infrared deformation changes the target's certain infrared imaging characteristic which can be easily identified by the infrared imaging system, by changing the infrared radiation's relative value and relative position of each part of the target, thus changes the certain infrared imaging characteristics which can be easily identified by the infrared imaging system, and makes it difficult for the enemy to identify or identify error.

2.2 Current status and developing trend of the infrared suppression technology

2.2.1 Current status

The current status and developing trend of the infrared suppression technology are shown in the infrared camouflage coating material and coat, infrared camouflage net and shielding, and the inherent infrared confrontation measure. There are many kinds of infrared paint and coating materials being developed in foreign countries, in which the "color-bearing coating material with infrared emissivity" of British, the "engine exhaust device infrared suppression coat" and "infrared coat" of the US are relatively advanced. The foreign armies have had great advancements in the area of infrared camouflage net and shielding, the infrared camouflage net and shielding which have been developed can effectively camouflage the normal temperature target and high temperature target, the

army is equipped with a large amount of them, and they are in the practical application stage. In these net and shielding, the "巴拉居达 infrared camouflage shielding" and 巴拉居达 infrared camouflage umbrella" of Sweden, the "奥古斯 infrared camouflage net" and "infrared camouflage coating material" of Germany, the "infrared camouflage tarpaulin", "multiple band camouflage net" and "Broad band camouflage shielding" of the US, all can represent the advanced level of the world.

Currently the inherent infrared confrontation measures appear with the appearance of the stealth technology. It is an advanced infrared camouflage technology that has the characteristic of both offense and defense. For the current technical level, the stealth technology of the airplane is mature, and also is in the practical application stage. The infrared confrontation technology for stationary targets on land and at sea developed somewhat later, and till now, have seen only small technical improvements. There is still a long way to go till practical application. The US army represents the world level in the area of the stealth technology of the flying target. At the same time, developing the inherent infrared camouflage technology is also the focal point and difficulty for the infrared camouflage development of each country.

2.2.2 Developing trend

The spectrum characteristic of future infrared paint and coating material will match the background, also will have the effect of counter millimeter wave radar and counter chemical pollution, at the same time it will have the "camouflage color" camouflage effect. In detail, it means to develop the paint and coating material of low infrared emissivity, and develop the infrared camouflage coating material whose emissivity changes with the temperature.

The camouflage performance of the infrared camouflage net in the medium and far infrared wave band can be close to or exceed the camouflage in the visible light and near infrared wave band, at the same time it has

the good capability of anti-radar camouflage. When the infrared camouflage net is used for the high temperature target, it should coordinate with the infrared suppression system. The concrete method is to develop the infrared camouflage net that can simulate the whole day temperature change cycle of the target's background, and also find more reasonable heat insulation lay structure and corresponding constructing technique.

The "inherent infrared confrontation measures of the target" is on the basis of the synthetic consideration of the target's tactical demand and physical capacity, redesign the military target concerning the /4 heat, firstly redesign the heat source in the target, secondly redesign the structure, material, shape and usage method of the target itself, thus it can realize the optimum control of the target's infrared characteristic, ensure that the target has not only good tactical performance, but also an infrared camouflage capacity. In detail, it means fixing the heat source in the target, developing and applying the general units or heat dissipation device, heat suppression device and heat shielding device, dissipating the thermal energy into the air without damage, also ensuring the temperature difference between the target and background reduce to below 4°C. The new infrared suppression coat that is developed for the metal target also can reduce the temperature difference between the target and background to below 4°C.

3. The technology of changing the medium's infrared transference characteristic

The typical example of this technology is the application of the infrared aerosol. Compared with the infrared suppression technology, the infrared aerosol technology has the ability of confronting the enemy's optical and electronic reconnaissance and attacking in real time, also it can quickly react for the enemy's optical and electronic guidance missile. So this technology attracts every country military attention.

3.1 The technical means and measures to change the medium's infrared transference characteristic

3.1.1 Developing the pyrotechnic infrared smoke agent

The pyrotechnic infrared smoke agent developed quickly in the 80's, many products were in their practical application stage, the main typical products include: hexachloroethane pyrotechnic infrared smoke agent of high polymer aromatic hydrocarbon being developed by the US, Germany, Holland, etc, the smoke produced by this kind of smoke agent has good infrared shielding ability. The performance of the Salty Dog series smoke agent being developed by the US navy is better than the former one.

3.1.2 Developing none pyrotechnic infrared smoke agent

Research in the US shows that the measures to enhance the conductivity of a material also can reduce the light detection characteristic of the particles of this material. The pyrotechnic infrared smoke agents being developed in recent years include the "multiple wave band shielding" of British, the "multiple usage blinding shielding agent" of the US and etc.

3.1.3 The casting and deployment equipment of the infrared aerosol

The foreign military has developed and equipped the army with the infrared smoke high explosive shell system, infrared smoke generator, infrared smoking can and airborne infrared smoke system.

3.2 The developing trends of the infrared aerosol

The developing trends of future infrared aerosol materials are: 1. The formed aerosol has the multiple wave band shielding ability, including visible light, infrared, laser, radar wave and etc.; 2. No poison, no pollution, and the material is cheap; 3. Have the capacity of anti red light, anti nuclear radiation, and anti biological weapon. The developing

trend of the casting and deployment equipment of future infrared aerosol is to integrate with the reconnaissance and warning equipment, integrate with decoy equipment, and spread large amount of smoke in large area.

4. Infrared deception technology

Current developing infrared deception technology is mainly the infrared decoy, the infrared decoys being used by foreign armies are mainly imaging infrared decoy and point source type infrared decoy. The point source type infrared decoys of foreign countries installed in the airplanes and naval ships are already very mature and effective, and have been tested in the battle field, but the effect of the point source type infrared decoy faces the serious threaten of the imaging infrared guidance technology. Comparatively speaking, the imaging infrared target is not very mature, the main problem is that it does not simulate the target's infrared image very well, the similarity is not adaptive to the infrared imaging guidance technology, also the all weather simulation performance is not good. Currently the typical samples of this kind of equipment include, the "infrared decoy" of the US, being used to simulate big vehicles, counter air to ground guided missile; the "film gas-filled type decoy" and "expandable foamed plastic decoy" with heat source of the US army; the "assemble type decoy" of Sweden.

The developing trend of the infrared deception technology is /5 that the future imaging infrared decoy not only can effectively simulate the infrared characteristic, but also has the optical, laser and radar wave deception capacity. The point source type decoy will integrate with the target, and integrate with other defense measures, thus become a organic component of the whole target and the whole defense system.

5. Conclusion

In the future battle field, with the extensive application of infrared reconnaissance and guidance technology, the infrared camouflage technology will certainly develop quickly, and give full play to its abilities in the battle field.

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